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B1X X22B
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GB 2237504 A GB 1456664 A GB 1378290 A
WO 92/12790 A1 US 4433916 A

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(54) Introducing ultrasound into a liquid containing chamber

(57) A method of introducing ultrasound into a liquid containing chamber such as a pipe 12 comprises forming an annular liquid filled region 16 around the chamber and introducing ultrasound through transducers 28 into the region and thereby into the chamber. The annular region may be defined by an annular metal sleeve 14 and spaced apart sealing means 18, the transducers being coupled externally to the annular sleeve. The sealing means may be flexible sealing members such as endless fluid or gas filled tubes (46, 48 figure 3) or flexible lip seals (51, 52 figure 4). The peak energy of the ultrasound may occur near an internal surface of the chamber and cause cavitation of the liquid at that surface. The liquid in the annular region may be the same or different to that in the chamber, it may be in contact with the chamber wall and may be at a higher pressure than that in the chamber, which may contain a mild chemical reagent to assist in descaling the inside surface of the chamber, the reactivity of the reagent being increased by the ultrasound.

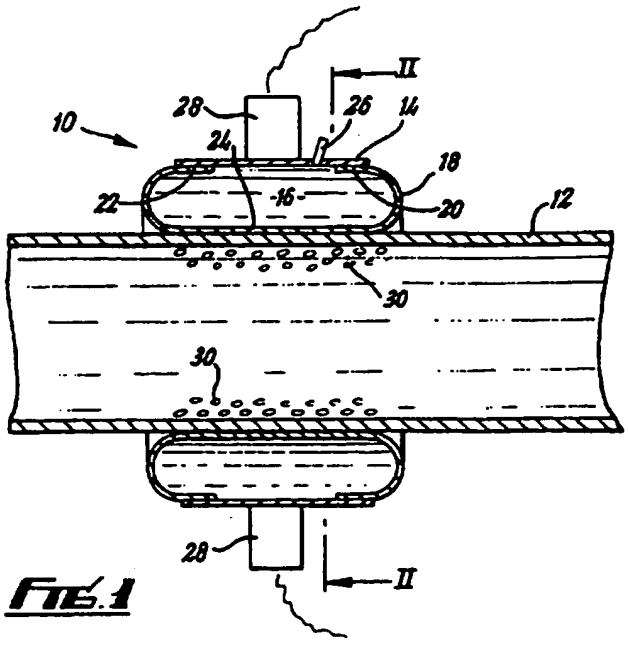

FIG.1

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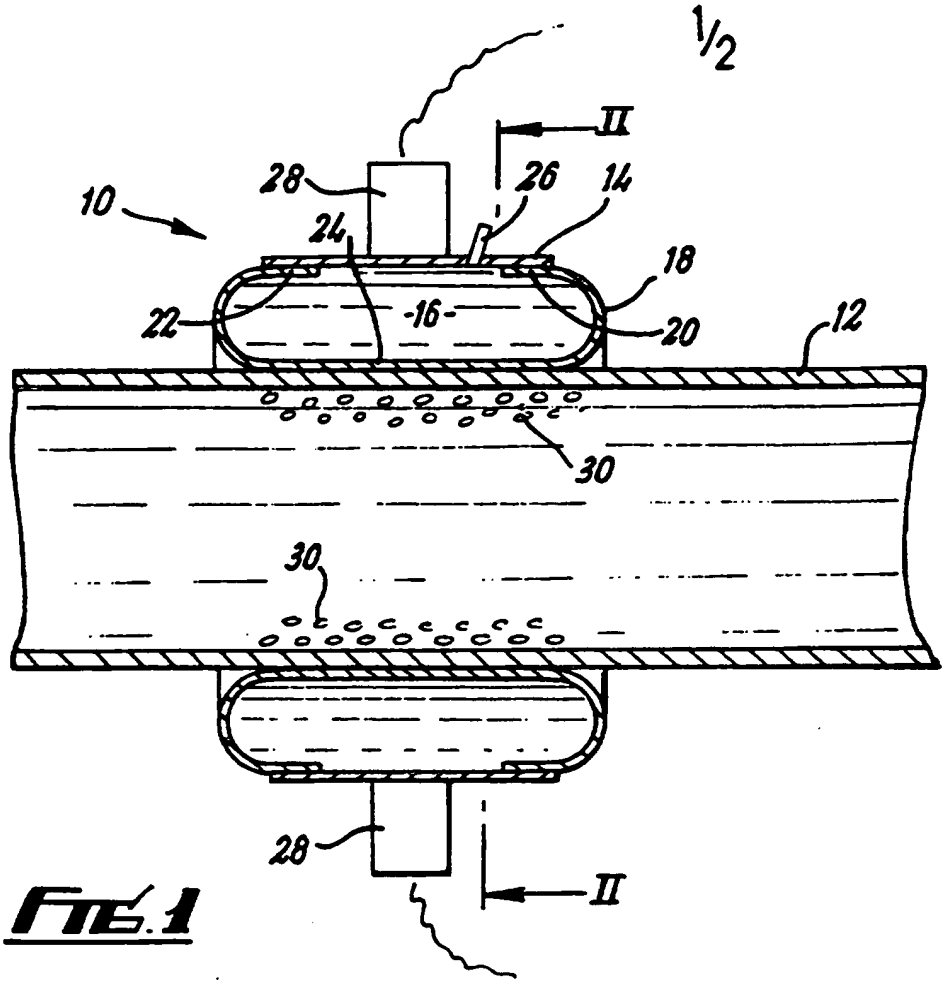
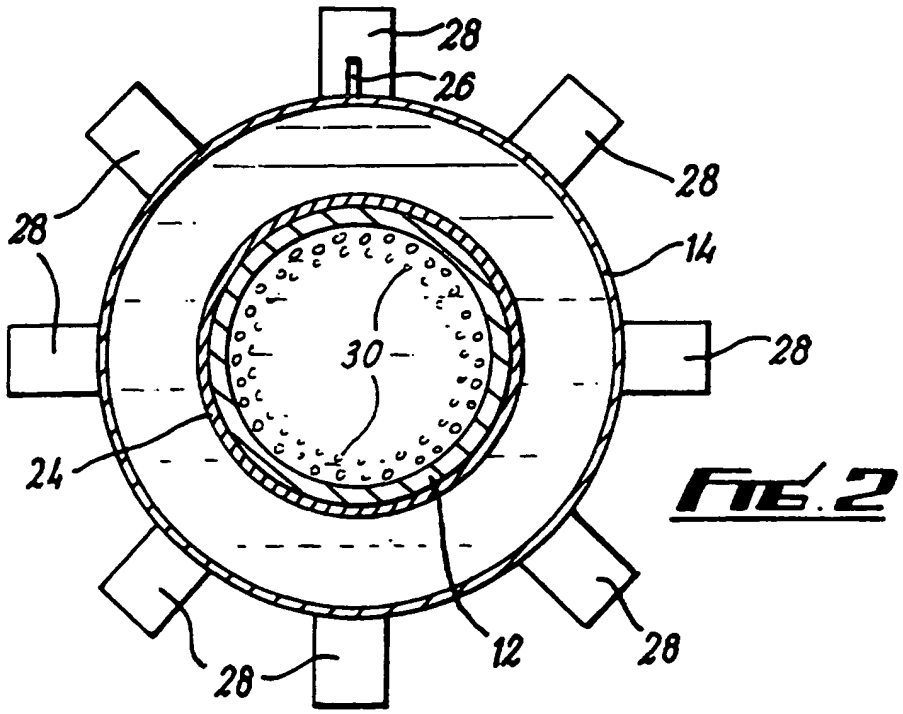

II
28
26
14
10
24
18
22
16
20
12
30
30
28
II

FIG. 1


28
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28

FIG. 2

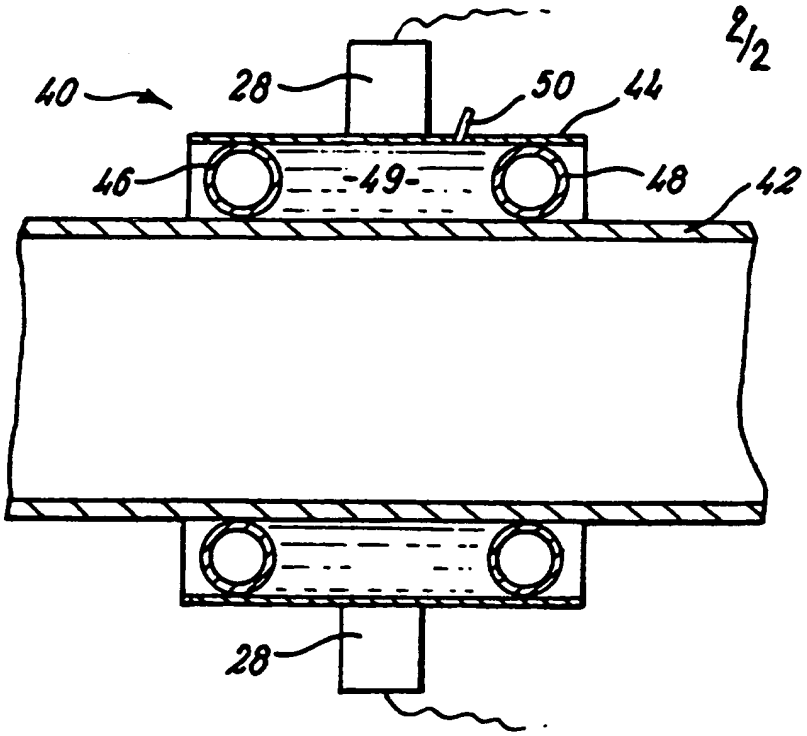

FIG. 3

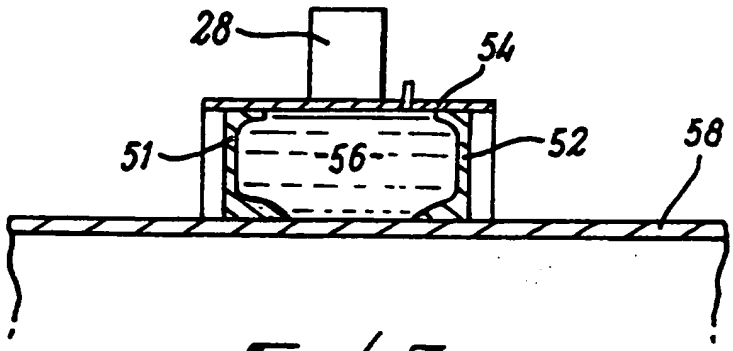

FIG. 4

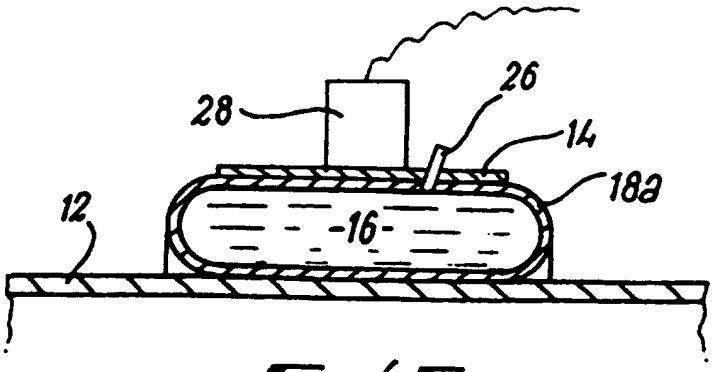

FIG. 5

An Ultrasonic Apparatus

This invention relates to ultrasonic apparatus, and more particularly to ultrasonic apparatus for introducing ultrasound into a chamber containing a liquid.

It is known that the introduction of ultrasonic energy into a liquid-filled chamber can lead to cavitation in the liquid - see for example "Sounding Out New Chemistry", by K Suslick and S Doktycz, New Scientist, pp50-53, 3 February 1990.

One of the problems associated with the use of ultrasound in such liquid-containing chambers is that of actually introducing the ultrasound into the chamber. With relatively large chambers an ultrasonic transducer can be inserted into the chamber, but there is a limit to the size of the chamber below which some external method has to be found for introducing ultrasonic energy into the chamber from an external source.

According to one aspect of the present invention, there is provided a method of introducing ultrasound into a liquid-containing chamber, the method comprising forming an annular liquid-filled region about a portion of the chamber, and introducing ultrasound into the region and thereby into the chamber.

According to another aspect of the present invention, there is provided apparatus for introducing ultrasound into a chamber, the apparatus comprising an annular metal member disposable about the chamber to define an annular space therebetween, sealing means disposed in the annular space in spaced-apart relationship so as to define an annular region therebetween, and at least one ultrasonic means coupleable externally to the annular member so as to introduce ultrasound into the region when the region contains a liquid and thereby into the chamber.

The chamber might comprise a duct, eg a pipe.

Preferably, the sealing means comprise flexible sealing members.

The liquid in the region might be the same as or different from a liquid in the chamber, it might be at a higher pressure, and might be in contact with the wall of the chamber.

The sealing means might comprise endless fluid-filled tubes, or flexible lip sealing members.

Preferably, the ultrasound is arranged such that the peak energy thereof occurs inside the chamber near to the inside surface of the chamber, and a node thereof occurs at the annular member.

The invention will now be further described by way of example only with reference to the accompanying drawings, in which:-

Figure 1 shows a medial sectional view of apparatus for introducing ultrasound into a pipe;

Figure 2 shows a view on the line II-II of Figure 1;

Figure 3 shows a modified form of the apparatus of Figure 1;

Figure 4 shows part of a modified form of the apparatus of Figure 3, and

Figure 5 shows part of another modification of the apparatus of Figure 1.

Referring now to Figures 1 and 2, an ultrasonic apparatus 10 is shown disposed about a chamber in the form of a liquid-filled metal pipe 12. The apparatus 10 comprises a thin metal annular sleeve 14 about the pipe 12 and defining an annular region 16 inside an annular flexible member 18. The member 18 at its outer surface defines short sides 20,22 that are bonded to the inside of the sleeve 14, and has a continuous wall 24 at its inner surface in close contact with the pipe 12. An inlet 26 in the sleeve 14 allows the region 16

to be filled with a liquid. A number (eight are shown) of ultrasonic transducers 28 are coupled to the outside of the sleeve 14 in equi-spaced relationship.

In operation, energising the transducers 28 causes ultrasound to be transmitted firstly through the sleeve 14 into the liquid (eg water) in the region 16, and then through the wall 24 and the pipe 12 where cavitation is caused in the liquid in the pipe 12 and shown by bubbles 30 in Figure 1. The thickness of the region 16 can be arranged and the wavelength of the ultrasound selected so that peak energy of the ultrasound occurs just inside the wall of the pipe 12. An optimum frequency of the ultrasound is about 20 kHz. Apart from mechanical effects of the imploding cavitating bubbles 30 in the liquid in the pipe 12, a high temperature and pressure are produced in the liquid at the bubbles 30 which assist in dislodging any scale, etc, that might be adhering to the inside of the pipe 12. The high temperature has the effect of locally increasing the reactive properties of any mild chemical reagent that might be introduced into the pipe 12 to assist in descaling the pipe 12.

Although the flexible member 18 has been shown as having outer surface with short sides 20 22, this outer surface could be continuous in a flexible member 18a (see Figure 5) like the wall 24 but with the disadvantage of some attenuation of the ultrasound from the transducers 28.

Referring now to Figure 3, an apparatus 40 is shown similar in many respects to the apparatus 10 of Figure 1 in having a thin metal annular sleeve 44 disposed about a metal pipe 42. Two gas filled (eg air) flexible, endless sealing tubes 46, 48 are disposed inside the sleeve 44 in spaced apart relationship to define an annular region 49

therebetween into which a liquid (eg water) is introduced through an inlet 50. A number (only two are shown) of ultrasonic transducers 28 are coupled to and disposed about the sleeve 44.

The apparatus 40 operates in a similar manner to the apparatus 10 of Figures 1 and 2, but has the advantage that the liquid in the region 49 is in direct contact with the pipe 42, and hence reduces the loss of ultrasonic energy in the transfer from the liquid in the region 49 to the pipe 42.

The flexible members 18, 18a, and the sealing tubes 46,48 might comprise rubber or plastics material.

Instead of using the flexible sealing tubes 46,48 of Figure 3, conventional flexible lip sealing members 51,52 (see Figure 4) may be used in opposing relationship inside a thin metal annular sleeve 54 to define an annular region 56 about a pipe 58. Ultrasonic transducers 28 are coupled to and disposed about the sleeve 54 so as to send ultrasound through the region 56 into and through the pipe 58.

It is an advantage if the liquid in the regions 16, 49 and 56 is at a higher pressure than the liquid in the pipe 12, 42, and may be the same as or different from the liquid in the pipe 12,42, 58.

For some applications, the transducers 28 might be mounted on metal waveguides (eg horns) secured to the sleeves 14, 44, 54. Usually when the invention is used for descaling the inside of a pipe, the transducers 28 will be arranged so that a node occurs at the sleeve 14, 44, 54, and the peak energy occurs just inside the pipe 12,42,58.

It will be understood that although the invention has been described in relation to descaling a chamber in the form of a pipe or duct, the invention may be used with other chambers where it is necessary to

inject ultrasonic energy into the chamber, not necessarily for descaling the chamber. If desired, fewer or more than eight ultrasonic transducers may be used depending on the application.

It will be appreciated that the ultrasonic energy might have the effect of inducing chemical reactions to take place in the chamber that would otherwise not occur or would have occurred at only an extremely slow rate.

Claims

1. A method of introducing ultrasound into a liquid-containing chamber, the method comprising forming an annular liquid-filled region about a portion of the chamber, and introducing ultrasound into the region and thereby into the chamber.

2. A method as claimed in Claim 1, wherein the ultrasound is arranged such that the peak energy thereof occurs inside the chamber near to the inside surface of the chamber.

3. A method as claimed in Claim 2, wherein the peak energy causes cavitation of the liquid thereat.

4. A method as claimed in any one of the preceding Claims wherein the ultrasound is arranged so that a node thereof occurs at the region.

5. A method as claimed in any one of the preceding Claims, wherein the liquid in the region is different from the liquid in the chamber.

6. A method as claimed in any one of the preceding Claims, wherein the liquid in the region is at a higher pressure than the liquid in the chamber.

7. A method as claimed in any one of the preceding Claims, wherein the liquid in the chamber includes a mild chemical reagent to assist in descaling the inside surface of the chamber, and the reactivity of the reagent is increased by the effect of the ultrasound.

8. A method as claimed in any one of the preceding Claims, wherein the liquid in the region is in direct contact with the wall of the chamber.

9. A method as claimed in any one of the preceding Claims, wherein the portion of the chamber is circular in cross-section, and the ultrasound is introduced through a plurality of transducers spaced around the region.

10. A method as claimed in any one of the preceding Claims, wherein the chamber comprises a duct.

11. A method as claimed in any one of the preceding Claims, wherein the ultrasound has a frequency of about 20 kHz.

12. A method of introducing ultrasound into a liquid-containing chamber, substantially as hereinbefore described with reference to Figure 1 and Figure 2, or Figure 3, or Figure 4, or Figure 5, of the accompanying drawings.

13. Apparatus for introducing ultrasound into a chamber, the apparatus comprising an annular metal member disposable about a portion of the chamber to define an annular space therebetween, sealing means disposed in the annular space in spaced-apart relationship so as to define an annular region therebetween, and at least one ultrasonic means coupleable externally to the annular member so as to introduce ultrasound into the region when the region contains a liquid and thereby into the chamber.

14. Apparatus as claimed in Claim 13, wherein the sealing means comprise flexible sealing members.

15. Apparatus as claimed in Claim 14, wherein the sealing members comprises endless fluid-filled tubes.

16. Apparatus as claimed in Claim 14, wherein the sealing members comprise flexible lip sealing members.

17. Apparatus as claimed in Claim 13, wherein the sealing means are integral with a flexible sealing member.

18. Apparatus as claimed in any one of Claims 13 to 17, including means for pressurizing the liquid in the region.

19. Apparatus as claimed in any one of Claims 13 to 18, wherein the portion is circular in cross-section, and a plurality of ultrasonic means are spaced around the metal member.

20. Apparatus as claimed in Claim 19, wherein the chamber comprises a duct.

21. Apparatus for introducing ultrasound into a chamber, substantially as hereinbefore described with reference to Figures 1 and 2, or Figure 3, or Figure 4, or Figure 5 of the accompanying drawings.

Patent Office

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Application No: GB 9520342.8 **Examiner:** Karl Whitfield
Claims searched: 1 to 21 **Date of search:** 7 November 1995

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.N): A4F, B1C, B1X, C7E, F2N, F4U

Int Cl (Ed.6): B01J, B01F, B08B, C23F, C23G, F28G

Other: Online database: wpi

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
Y	GB 2237504 A	(KERRY) whole document	1 at least
Y	GB 1456664	(DAWE) whole document	1 at least
Y	GB 1378290	(DAWE) whole document	1 at least
Y	WO 92/12790 A1	(VAXELAIRE) abstract & figs	1 at least
Y	US 4433916	(HALL) whole document	1 at least

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